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CELL CONTROLLER OPERATIONS MANUAL

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By:
Bruce H. Thomas

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Bruce Hunter Thomas

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I. INTRODUCTION

This manual is one in a series of operations manuals written to instruct a novice in the operation of one of the systems in the Automated Manufacturing Research Facility (AMRF) at the National Bureau of Standards. The manual assumes that the operator has some training in the use of the computer but little knowledge of the AMRF and only wants to operate the specific system in a standard configuration, not learn how or why it operates as it does. A reader interested in further information about the system should consult this document's bibliography for a list of other publications on the subject.

The AMRF, the major national laboratory for research in automated manufacturing, consists of six workstations and the control rooms and computer equipment necessary to operate them. The facility is a test bed where scientists and engineers from industry, academia, and the government work together on projects of mutual interest. Their research concentrates on the interfaces and measurement techniques needed for successful computer integrated manufacturing.

This particular manual addresses the operation of the AMRF's cell controller. The cell controller is currently the highest level controller in the AMRF. The cell controller directs the actions of five subordinate workstations: Vertical Workstation (VWS), Horizontal Workstation (HWS), Inspection Workstation (IWS), Material Handling Workstation (MHS), and Cleaning and Deburring Workstation (CDWS). There are four major sections to this manual, basic operation of the cell screen management system, startup of the cell, operation of the cell, and shutdown of the cell.

The cell controller is located in Control Room 2 on the desk facing the window. The cell controller is running on a COMPAQ deskpro 386 computer, and requires software to be running concurrently on the Sun Network computer. The Sun computer is located on the table to left of the COMPAQ 386, as you face the COMPAQ.

II. OPERATION OF THE SCREENS

The cell's screens are broken down into three major areas: menu area, data area, and the status bar. Figure 1 shows the location of the three areas on the screen.

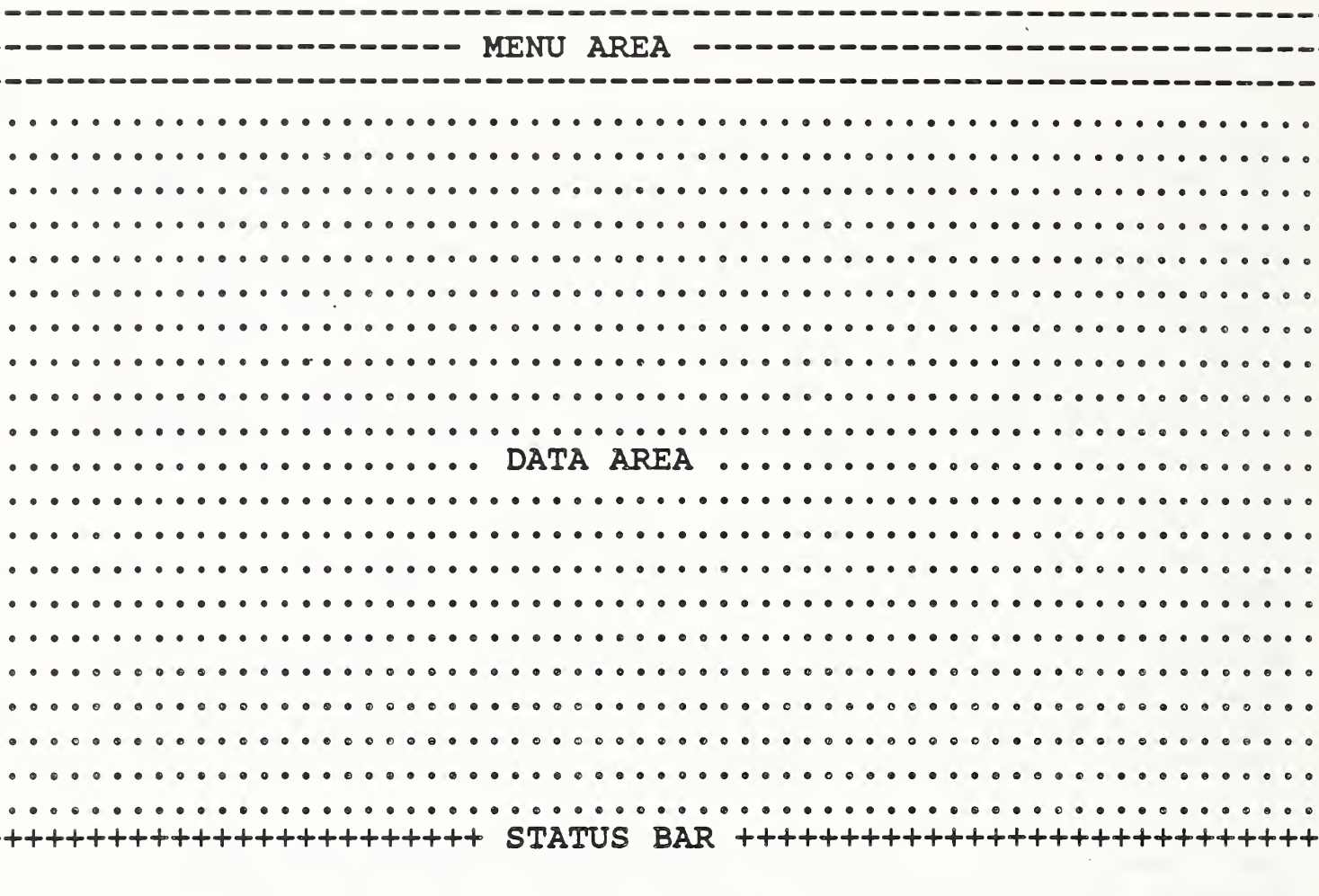


Figure 1. Cell Screen Area

Most user interaction with the system is directed through the menu area. The menu area occupies the topmost three lines on the monitor screen. The first line displays the name of the menu that the user has currently selected. The second line provides selection operations or data that may be chosen by the user. Left and right cursor control keys move the highlighting bar over the possible selections. The cursor control, or "arrow", keys are located on the number key pad on the right side of the keyboard. Pressing the ENTER key makes a selection which will cause an associated menu function to be called and/or another level of descent in the menu structure to occur. Pressing the ESCAPE key causes the user to back up a level in the menu structure. Function keys provide the user with direct access to many functions and screens, which are listed below. The third line displays the next level of options with the selection that is currently highlighted on line 2.

Function keys:

F1: Not used
F2: Move from menu to data area

F3: Communication state data display
F4: Mailbox display
F5: Cell control command display
F6: Cell control status display
F7: Summary display
F8: Work elements display
F9: Communication display
F10: Subordinate controller

Most of the information about the cell is presented in the second area on the screen, the data page. The data page covers from line 4 to line 24 on the screen. Many different page formats are defined which provide control and communications information to the user in real-time.

The last area on the screen, the status bar, provides summary or diagnostic information. The highlighted status bar displays the current clock cycle, the current screen identifier, communications status, and the current time. It provides constant feedback to the user that the cell is operating correctly. The current clock cycle should be updating about ten times a second. If the clock cycles have stopped updating for more than a few seconds, the system might have abnormally stopped. When the system has abnormally stopped, the computer must be turned off and then turned on. The computer is then rebooted, and the startup procedure is repeated.

III. STARTUP

1. CELL CONTROLLER STARTUP

1) The Sun MHS and CELL communications processes are started by either the Network operator or the AMRF operator.

2) Check that the power strip is connected to the COMPAQ 386 and there is no diskette in the disk drive. Check that the computer's power switch is on. When the COMPAQ 386 is ready to operate, the prompt

```
C>
```

will be the last item written on the screen.

3) To start the cell controller on the COMPAQ 386 enter commands

```
c:
cd cell
cell
```

See Figure 2 in the Appendix. The figures of the cell screens are to help users determine if their keyboard actions are producing the desired effects. The cell takes a few seconds to startup; therefore wait until clock cycles start updating before proceeding.

4) Using the arrow keys, highlight the menu option SET_COMM. Press the Enter key. See Figure 3.

5) Using the arrow keys, highlight the menu option COMM_SWITCH. Press the Enter key. See Figure 4.

6) Using the arrow keys, highlight the menu option ON. Press the Enter key. See Figure 5. (Observe on the status bar the COMM: status should be switching from IDLE to RCV about every ten seconds.) This activates communication between the cell computer and the Sun that provides a connection to the AMRF Network.

7) Enter the Esc key to return to the SET_COMM menu.

8) Enter the Esc key again to return to the main menu, CELL.

2. UNIVERSITY OF VIRGINIA (UVA) PROTOCOL TO WORKSTATIONS

9) Enter the F7 function key to bring up the Summary display. See Figure 6.

10) Using the arrow keys, highlight the menu option SET_CMDS. Press the Enter key. See Figure 7.

11) For each subordinate workstation that is being used, perform the next 6 steps on each workstation. An example of initializing the Cleaning and Deburring Workstation is shown.

12) Using the arrow keys, highlight the menu option for the workstation desired (for this example use CDWS). Press the Enter key. See Figure 8.

13) Using the arrow keys, highlight the menu option SYNC. Press the Enter key. See Figure 9.

14) Wait for the workstation to return a SHUTDOWN status. See Figure 10.

15) Using the arrow keys, highlight the menu option WARM. Press the Enter key. See Figure 11.

16) Wait for the workstation to return a READY status. See Figure 12.

17) Enter the Esc key to return to the SET_CMDS menu.

18) If there are more subordinate workstations to be initialized, repeat steps 12 through 19 for each workstation.

19) Enter the Esc key, and this will return to the main menu.

20) The cell controller is now fully operational.

IV. OPERATION OF THE CELL

There are two main operations the cell can perform, entering orders and monitoring.

1. ORDER ENTRY

To enter an order do the following.

1) While in the main menu CELL, use the arrow keys to highlight the menu option ORDERS and press the Enter key. See Figure 13.

2) Using the arrow keys, highlight the menu option ENTRY. Press the Enter key. See Figure 14. (The list of orders in the figure is an example of a possible screen.)

3) To select an order use the up and down arrows to highlight the desired order. Once the correct order has been highlighted, press the Enter key. The cell will acknowledge by displaying the message ORDER ACCEPTED, see Figure 15.

4) To enter another order repeat step 3.

5) If there are no more orders to select, press the Esc key. The menu area for the ORDERS screen will return, see Figure 16.

6) Press the Esc key and the main menu CELL will return.

7) To enter more orders in the future return to the ORDER ENTRY screen and repeat steps 2 through 4.

2. MONITORING

The second operation of the cell is to monitor the status messages of the subordinate workstations. This monitoring is displayed on the summary screen. To bring up the summary screen enter the function key F7. An example of the summary screen is shown in Figure 17. The summary screen shows the commands being sent to the subordinate workstations and the

status of the workstation. In this example, the Inspection Workstation was given a work order to receive a tray with a lot type of MIXED and quantity of four items in the lot. The Material Handling Workstation is in a READY state.

V. SHUTDOWN

1) Return to the main menu CELL by entering the Esc key until the main menu CELL is on the screen.

2) Using the arrow keys, highlight the menu option SET_CMDS. Press the Enter key.

3) Press the function key F7 to bring up the summary screen. (This will blank out the menu area. The menu area will return when an arrow key is entered.)

4) For each subordinate workstation that is being used, perform the next 4 steps. (An example of shutting down the Cleaning and Deburring Workstation is shown.)

5) Using the arrow keys, highlight the menu option for the workstation desired (for this example use CDWS). Press the Enter key.

6) Using the arrow keys, highlight the menu option SHUTDOWN. Press the Enter key. See Figure 18.

7) Wait for the workstation to return a SHUTDOWN status. The COMPAQ's screen should look roughly like Figure 19 when the SHUTDOWN status has been returned.

8) Enter the Esc key to return to the SET_CMDS menu.

9) If there are more subordinate workstations to be shutdown, repeat steps 5 through 8 for each workstation.

10) Using the arrow keys, highlight the menu option EXIT. Press the Enter key. See Figure 20 for the menu portion of the EXIT screen.

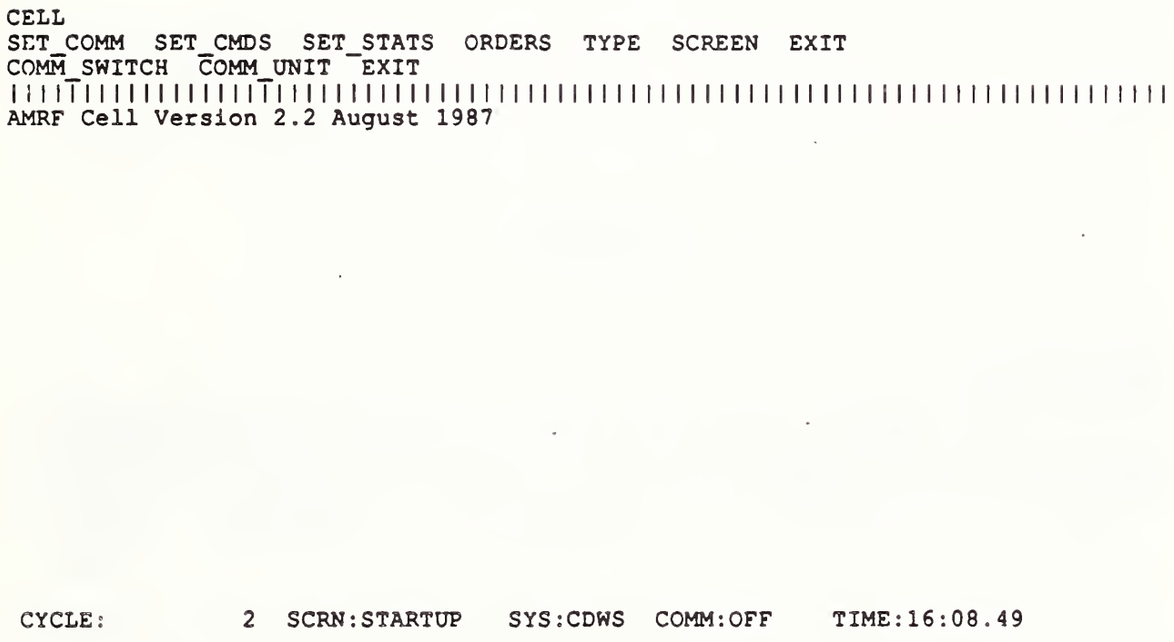
11) Using the arrow keys, highlight the menu option YES. Press the Enter key.

12) The COMPAQ computer's prompt should return on the screen.

13) Turn off the power on the COMPAQ computer.

14) The cell controller is now shutdown.

APPENDIX FIGURES OF CELL SCREENS


CELL
SET_COMM SET_CMDS SET_STATS ORDERS TYPE SCREEN EXIT
COMM_SWITCH COMM_UNIT EXIT
AMRF Cell Version 2.2 August 1987
CYCLE: 2 SCRN:STARTUP SYS:CDWS COMM:OFF TIME:16:08.49

CELL Menu
Figure 2

```
SET_COMM
COMM_SWITCH  COMM_UNIT  EXIT
ON  OFF  EXIT
||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
AMRF Cell Version 2.2 August 1987




 CYCLE:          4  SCRN:STARTUP    SYS:CDWS  COMM:OFF     TIME:13:39.18
```

SET COMM Menu
Figure 3

```
COMM_SWITCH
ON  OFF  EXIT

||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
AMRF Cell Version 2.2 August 1987




 CYCLE:          5  SCRN:STARTUP    SYS:CDWS  COMM:OFF     TIME:13:39.20
```

COMM_SWITCH Menu
Figure 4

```
COMM_SWITCH
ON  OFF  EXIT

||||||
```

```
SET_CMDS
CDWS  HWS  IWS  MHS  TWS  VWS  VISION  EXIT
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT
||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Ctlr Msg  Transition          Order                Element            Lot Type
Name Nr   # - Keyword         # - Keyword           & Plan Id          & Qty
CDWS 0    0
     0    0
--------------------------------------------------------------------------------
HWS  0    0
     0    0
--------------------------------------------------------------------------------
IWS  0    0
     0    0
--------------------------------------------------------------------------------
MHS  0    0
     0    0
--------------------------------------------------------------------------------
TWS  0    0
     0    0
--------------------------------------------------------------------------------
VWS  0    0
     0    0
--------------------------------------------------------------------------------
 CYCLE:          3  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:36.45
```

SET_CMDS Menu
Figure 7

```
CDWS
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT

||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Ctlr Msg  Transition          Order                Element            Lot Type
Name Nr   # - Keyword         # - Keyword           & Plan Id          & Qty
CDWS 0    0
     0    0
--------------------------------------------------------------------------------
HWS  0    0    .
     0    0
--------------------------------------------------------------------------------
IWS  0    0
     0    0
--------------------------------------------------------------------------------
MHS  0    0
     0    0
--------------------------------------------------------------------------------
TWS  0    0
     0    0
--------------------------------------------------------------------------------
VWS  0    0
     0    0
--------------------------------------------------------------------------------
 CYCLE:          4  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:36.47
```

CDWS Menu
Figure 8

```
CDWS
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT

||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Ctlr Msg  Transition        Order              Element            Lot Type
Name Nr   # - Keyword       # - Keyword         & Plan Id          & Qty
CDWS 1    1   SYNC
     0    0
--------------------------------------------------------------------------------
HWS  0    0
     0    0
--------------------------------------------------------------------------------
IWS  0    0
     0    0
--------------------------------------------------------------------------------
MHS  0    0
     0    0
--------------------------------------------------------------------------------
TWS  0    0
     0    0
--------------------------------------------------------------------------------
VWS  0    0
     0    0
--------------------------------------------------------------------------------
 CYCLE:         5  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:36.51
```

CDWS Menu
Figure 9

```
SET_CMDS
CDWS  HWS  IWS  MHS  TWS  VWS  VISION  EXIT
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT
||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Ctlr Msg  Transition        Order              Element            Lot Type
Name Nr   # - Keyword       # - Keyword         & Plan Id          & Qty
CDWS 1    1   SYNC
     1    1   SHUTDOWN
--------------------------------------------------------------------------------
HWS  0    0
     0    0
--------------------------------------------------------------------------------
IWS  0    0
     0    0
--------------------------------------------------------------------------------
MHS  0    0
     0    0
--------------------------------------------------------------------------------
TWS  0    0
     0    0
--------------------------------------------------------------------------------
VWS  0    0
     0    0
--------------------------------------------------------------------------------
 CYCLE:        12  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:37.11
```

SET_CMDS Menu
Figure 10

```
CDWS
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT

||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Ctlr Msg  Transition          Order                Element              Lot Type
Name Nr   # - Keyword         # - Keyword           & Plan Id            & Qty
CDWS 1    1   WARM_STARTUP
     1    1   SHUTDOWN
--------------------------------------------------------------------------------
HWS  0    0
     0    0
--------------------------------------------------------------------------------
IWS  0    0
     0    0
--------------------------------------------------------------------------------
MHS  0    0
     0    0
--------------------------------------------------------------------------------
TWS  0    0
     0    0
--------------------------------------------------------------------------------
VWS  0    0
     0    0
--------------------------------------------------------------------------------
 CYCLE:        13  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:37.14
```

CDWS Menu
Figure 11

```
SET_CMDS
CDWS  HWS  IWS  MHS  TWS  VWS  VISION  EXIT
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT
||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Ctlr Msg  Transition          Order                Element              Lot Type
Name Nr   # - Keyword         # - Keyword           & Plan Id            & Qty
CDWS 1    1   WARM_STARTUP
     1    1   READY
--------------------------------------------------------------------------------
HWS  0    0
     0    0
--------------------------------------------------------------------------------
IWS  0    0
     0    0
--------------------------------------------------------------------------------
MHS  0    0
     0    0
--------------------------------------------------------------------------------
TWS  0    0
     0    0
--------------------------------------------------------------------------------
VWS  0    0
     0    0
--------------------------------------------------------------------------------
 CYCLE:        19  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:37.31
```

SET_CMDS Menu
Figure 12

```
ORDERS
ENTRY  STATUS  HISTORY  EXIT

||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
AMRF Cell Version 2.2 August 1987




 CYCLE:          3  SCRN:STARTUP    SYS:CDWS  COMM:IDLE    TIME:16:11.50
```

ORDERS Menu
Figure 13

```
||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
ORDER ENTRY

 SEQ  PART_ID                BATCH_ID                        FILE

   1  MIXED_510              IWS_510                              PLAN5
   2  MIXD_520               IWS_520                              PLAN22
   3  MIXED_530              IWS_530                              PLAN6
   4  DOG                    CWS_400                              PLAN20
   5  LCLEVIS                CWS_440                              PLAN21
   6  BLOCK_FH               CWS_410                              PLAN7
   7  PIPECLAMP_FV           CWS_430                              PLAN8
   8  NIPPLE                 TWS_303                              PLAN19
   9  SLBEARING              TWS_305                              PP_CELL_183
  10  LCLEVIS                VWS_200                              PLAN10



 CYCLE:          3  SCRN:SEQS       SYS:CDWS  COMM:IDLE    TIME:16:11.51
```

ORDER ENTRY Screen
Figure 14

ORDER ENTRY

SEQ	PART_ID	BATCH_ID	FILE
1	MIXED_510	IWS_510	PLAN5
2	MIXED_520	IWS_520	PLAN22
3	MIXED_530	IWS_530	PLAN6
4	DOG	CWS_400	PLAN20
5	LCLEVIS	CWS_440	PLAN21
6	BLOCK_FH	CWS_410	PLAN7
7	PIPECLAMP_FV	CWS_430	PLAN8
8	NIPPLE	TWS_303	PLAN19
9	SLBEARING	TWS_305	PP_CELL_183
10	LCLEVIS	VWS_200	PLAN10

ORDER ACCEPTED

CYCLE: 4 SCRN:SEQS SYS:CDWS COMM:IDLE TIME:15:14.42

ORDER ENTRY Screen
Figure 15

ORDERS
ENTRY STATUS HISTORY EXIT

ORDER ENTRY

SEQ	PART_ID	BATCH_ID	FILE
1	MIXED_510	IWS_510	PLAN5
2	MIXED_520	IWS_520	PLAN22
3	MIXED_530	IWS_530	PLAN6
4	DOG	CWS_400	PLAN20
5	LCLEVIS	CWS_440	PLAN21
6	BLOCK_FH	CWS_410	PLAN7
7	PIPECLAMP_FV	CWS_430	PLAN8
8	NIPPLE	TWS_303	PLAN19
9	SLBEARING	TWS_305	PP_CELL_183
10	LCLEVIS	VWS_200	PLAN10

CYCLE: 5 SCRN:SEQS SYS:CDWS COMM:IDLE TIME:15:14.46

ORDERS Menu
Figure 16

```
CELL
SET_COMM  SET_CMDS  SET_STATS  ORDERS  TYPE  SCREEN  EXIT
ENTRY  STATUS  HISTORY  EXIT
||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Ctlr Msg  Transition          Order              Element            Lot Type
Name Nr   # - Keyword         # - Keyword         & Plan Id          & Qty
CDWS 0    0
     0    0
-------------------------------------------------------------------------------
HWS  0    0
     0    0
-------------------------------------------------------------------------------
IWS  0    0                   2    EXECUTE       RECEIVE_TRAY       MIXED
     0    0                        NO_STATUS                        4
-------------------------------------------------------------------------------
MHS  0    0
     1    0   READY
-------------------------------------------------------------------------------
TWS  0    0
     0    0
-------------------------------------------------------------------------------
VWS  0    0
     0    0
-------------------------------------------------------------------------------
 CYCLE:          6  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:11.59
```

CELL Menu
Figure 17

```
 CDWS
 SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT

 ||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
 Ctlr Msg  Transition          Order              Element            Lot Type
 Name Nr   # - Keyword         # - Keyword         & Plan Id          & Qty
 CDWS 1    1   WARM_SHUTDOWN
      1    1   READY
 -------------------------------------------------------------------------------
 HWS  0    0
      0    0
 -------------------------------------------------------------------------------
 IWS  0    0
      0    0
 -------------------------------------------------------------------------------
 MHS  0    0
      0    0
 -------------------------------------------------------------------------------
 TWS  0    0
      0    0
 -------------------------------------------------------------------------------
 VWS  0    0
      0    0
 -------------------------------------------------------------------------------
  CYCLE:         22  SCRN:SUMMARY   SYS:CDWS  COMM:IDLE   TIME:16:37.42
```

CDWS Menu
Figure 18

```
CDWS
SYNC  WARM  CDWS_LOT_TYPE  RCV_TRAY  DBURR_LOT  SHIP_TRAY  SHUTDOWN  EXIT

|||||||
```

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11. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)*

This manual is designed to show a novice user how to startup, operate, and shutdown the cell controller. The manual assumes the operator knows the basic operation of a PC-clone computer. There are four major sections to this manual, basic operation of the cell screen management system, startup of the cell, operation of the cell, and shutdown of the cell.

12. KEY WORDS *(Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)*

Cell control, user's manual, manufacturing, AMRF

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